CLAIMS

1. A method for programming an industrial robot (1) to move relative to defined positions on an object (4), wherein the programming is based on a geometric model (34) of the object, characterized in that the method comprises:
- registering and storing a plurality of measuring points, each measuring point corresponding to a point on the surface of the real object expressed in any coordinate system (32, 100) associated with the robot,
- determining the orientation and position of the geometrical model of the object relative to said coordinate system associated with the robot by adapting the geometrical model of the object and the measuring points to each other,
- calculating the deviation (48) between the measuring points (44) and corresponding points (45) on the geometrical model for at least some of the measuring points, and
- adjusting said defined positions based on said calculated deviations.

2. A method according to claim 1, characterized in that it further comprises:
- calculating one or a plurality of characteristic parameters for a plurality of different parts of the object based on the geometrical model of the object,
- determining to which part (20, 21) of the object a measuring point belongs based on said characteristic parameters, and
- said adapting of the geometrical model of the object to the measuring points comprises adapting measuring points belonging to a certain part of the object to the corresponding part of the geometrical model.

3. A method according to claim 2, characterized in that said parts comprise surfaces (20) and edge lines (21) of the object.

4. A method according to any of the claims 1-3, characterized in that it further comprises:
- providing geometric models for a plurality of different objects,
- calculating a plurality of characteristic parameters for each of the objects based on the geometrical model of the object, and
- determining to which of the objects the measuring points belong based on the measuring points and said characteristic parameters.

5. A method according to any of the claims 2-4, characterized in that said characteristic parameters comprise the normal direction relative to the surface of the object and the bending (25) of the surface of the object.

6. A method according to any of the preceding claims, characterized in that the geometrical model of the object and the measuring points are adapted to each other by minimizing the distance between the measuring points and corresponding points on the geometrical model of the object.

7. A method according to any of the previous claims, characterized in that the surfaces of the object are divided into a plurality of sub-surfaces (42), each comprising at least one measuring point, calculating a correction vector (46) based on the deviation (48) between the measuring point/measuring points in the sub-surface and corresponding point/points on the geometrical model of the object, and adjusting said defined positions based on the correction vectors for sub-surfaces belonging to the positions.

8. A method according to any of the previous claims, characterized in that the edge lines of the object are divided into a plurality of line segments, each comprising at least one measuring point, calculating a correction vector based on the deviation between the measuring point/measuring points in the line segment

and corresponding point/points on the geometrical model of the object, and adjusting said defined positions based on the correction vectors for line segment in the vicinity of the defined positions.

9. A method according to any of the preceding claims, characterized in that said defined positions are defined relative to the geometrical model and that the defined positions are transformed to said associated coordinate system based on the determined orientation and position of the geometrical model relative to the coordinate system associated with the robot.

10. A method according to any of the preceding claims, characterized in that said measuring points correspond to the positions of the robot when a predetermined point on a tool, or a measuring device (14) corresponding to the current tool, is in contact with different points on the surface of the object.

11. A method according to any of the claims 1-10, characterized in that the method comprises generating a surface-scanning program for automatically controlling the movements of the robot during measuring of said measuring points.

12. A method according to claim 11, characterized in that a sensor is mounted on a tool or on a measuring device corresponding to the current tool and that the sensor cooperates with the robot during generation of said measuring points.

13. A method according to claim 12, characterized in that the surface scanning program controls the movements of the robot during measuring of the measuring points, wherein said movements comprises moving the robot so that the sensor is in contact with the surface of the object during the measuring and that the robot thereafter is moved to a transfer point positioned at a distance from the surface of the object.

14. A method according to any of the claims 12 and 13, characterized in that the orientation of the tool in the defined positions are stored and that the program is generated so that the tool or said measuring device have about the same orientation in a measuring point as the stored orientation.

15. A method according to any of the claims 11-14, characterized in that the positions of the measuring points are determined off-line based on the geometrical model of the object.

16. A method according to any of the claims 11-14, characterized in that the method comprises that a number of positions, comprising at least one start position and one stop position are measured on the surface of the real object and that the positions of the measuring points are automatically generated based on the measured positions.

17. A computer program directly loadable into the internal memory of a computer and comprising instructions to make a processor perform the steps in the method according to any of the claims 1-16.

18. A computer readable medium comprising a computer program, comprising instructions to make a processor carry out the steps in the method according to the claims 1–16.

19. A system for programming an industrial robot (1) to move relative to defined positions on an object (4), wherein the system comprises a geometric model (34) of the object, characterized in that the system further comprises:

- the real object (4),
- an industrial robot (1), wherein the real object and the robot are arranged to that it is possible to, by means of the robot, generate a plurality of measuring points corresponding to different points on the surface of the real object expressed in a coordinate system (32, 100) associated with the robot,

- a calibration module (17) arranged to determine orientation and position of the geometrical model of the object relative to said coordinate system associated with the robot by adapting the measuring points to the geometrical model of the object,
- a calculating module (18) arranged to calculate the deviation (48) between the measuring points (44) and corresponding points (45) on the geometrical model, and
- an adjusting module (19) arranged to adjust said defined positions based on said calculated deviations.

20. A system according to claim 19, characterized in that the system comprises a measuring device (14) adapted for being in contact with the surface of the object during measuring, wherein the measuring device has a center point corresponding to the tool center point (TCP) of the current tool.

21. A system according to claim 20, characterized in that the measuring device (14) is adapted to, at contact with the object, submit a signal, and that the system is adapted to, in reply to said signal, generate at least one measuring point based on the robot position.

22. A system according to any of the claims 19-21, characterized in that the system comprises a part classification module (16a) arranged to calculate one or a plurality of characteristic parameters for a plurality of different parts (20, 21) of the object, based on the geometrical model for the object, and to determine to which part of an object a measuring point belongs, based on said characteristic parameters, wherein said calibration module (17) is adapted to execute said adaption of the geometrical model of the object to the measuring points by adapting the measuring points belonging to a certain part of the object to a corresponding part of the geometrical model.

23. A system according to claim 22, characterized in that said parts comprises surfaces (20) and edge lines (21) of the object.

24. A system according to any of the claims 19-23, characterized in that the system further comprises geometric models for a plurality of different objects and an object classification module (16b) arranged to calculate a plurality of characteristic parameters for each of the objects based on the geometrical model of the objects and to determine to which of the different objects the measuring point belongs based on the measuring points and the calculated characteristic parameters.

25. A system according to any of the claims 22-24, characterized in that said characteristic parameters comprise the normal direction relative to the surface of the object and the bending (25) of the surface of the object.

26. A system according to any of the claims 19-25, characterized in that said calibration module (17) is arranged for adapting the geometrical model of the object and the measuring points to each other by minimizing the distance between the measuring points and corresponding points of the geometrical model of the object.

27. A system according to any of the claims 19-26, characterized in that said adjusting module (19) comprises means for dividing the surfaces of the object into a plurality of sub-surfaces (42), each comprising at least one measuring point and the adjusting module is arranged to calculate a correction vector for the sub-surfaces based on the deviation between the measuring point/measuring points of the sub-surface and corresponding point/points on the geometrical model of the object, and to adjust said defined positions based on the correction vectors for the sub-surfaces to which the positions belong.

28. A system according to any of the claims 19-27, characterized in that said adjusting module (19) comprises means for dividing the edge lines of the object into a plurality of line seg-

ments, each comprising at least one measuring point and the adjusting module is arranged to calculate a correction vector for each line segment based on the deviation between the measuring point/measuring points in the line segment and corresponding point/points on the geometrical model of the object and to adjust said defined positions based on the correction vectors for the line segment in the vicinity of the defined positions.

29. A system according to any of the claims 19-28, wherein said defined positions are defined relative to the geometrical model, characterized in that said adjusting module comprises means for transforming said defined positions to said coordinate system associated with the robot, based on the determined orientation and position of the geometrical model relative to a said coordinate system.

30. A system according to any of the claims 19-29, characterized in that the system comprises a program generator, arranged for generating a surface scanning program for automatically controlling the movement of the robot during measuring of said measuring points.

31. A system according to claim 30, characterized in that said program generator is arranged for automatically generate said surface scanning program based on certain input from an operator.

32. A system according to any of the claims 30 and 31, characterized in that the system comprises a sensor mounted on a tool, or a measuring device corresponding to the current tool, and that the sensor is arranged to cooperate with the robot for generating said measuring points.

33. A system according to any of the claim 32, characterized in that said sensor is a position sensor arranged for measuring the

distance between the surface of the object and any part of the robot.

34. A system according to any of the claims 32 and 33, characterized in that the surface scanning program controls the movement of the robot during measuring of the measuring points, wherein said movements comprises that the robot is moved so that the sensor is in contact with the surface of the object during the measuring and that the robot thereafter is moved to a transfer point being positioned at a distance from the surface of the object.

35. A system according to any of the claims 30-34, characterized in that the program generator is arranged in an external computer and that the program generator is arranged to determine the positions of the measuring points based on the geometrical model of the object.

36. A system according to any of the claims 30-34, characterized in that the program generator is arranged in the control system of the robot and that the program generator is arranged for generating the positions of the measuring points based on a plurality of positions measured at the surface of the real object, which positions comprise at least one start position and one stop position.